

MODIS Science Team Member

Semi-annual Report

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A. FOCUS ACTIVITIES DURING THE REPORTING

The most important activities undertaken during this reporting period are the following:

1. MOD09 Testing and code delivery.
2. Implementation of a coarse resolution product in Level 2 and Level 3 MOD09.
3. Implementation of test sites logging in Level 2 MOD09 code
4. MOD09 QA plan.
5. Development of a QA tool for MOD09.
6. MOD09 validation activities.
7. Improvements to the Synthetic data generator.
8. Aerosol climatology.
9. Aerosol retrieval from AVHRR and SeaWiFS data.
10. Aerosol transport modeling.
11. MEBS Week in Life Test.
12. MODIS Adaptive Processing System (MODAPS).

1. MOD09 Testing and code delivery

Extensive testing of MOD09 code has been undertaken at the SCF in an effort to assess the performance and stability of the code under various circumstances. To assist with this activity, MOD04 (L2 aerosol) and MOD07 (MODIS ozone) codes were obtained from the atmosphere group and used to generate upstream products needed by MOD09. Special simulated Level 1B granules containing various levels of noise and inconsistencies were created for that purpose. Several slight modifications to the code resulted from this exercise and were delivered to SDST in form of patches.

2. Implementation of a coarse resolution product in Level 2 and Level 3 MOD09

To reduce the effort needed for the inspection of the generated MOD09 products we opted for the creation of an interim MOD09 coarse resolution product that will be used as the first step in the QA process. This product will help to locate areas that need special attention and where further investigation of the full resolution is required. The coarse resolution product is produced at 5 km resolution by averaging the full resolution pixels. Cloudy and low quality input pixels will be excluded from the averaging process when possible, otherwise the coarse resolution flag will be set to indicate an irregular situation.

3. Implementation of test sites logging in Level 2 MOD09 code

Another feature to help with the evaluation and the validation of the land surface reflectance algorithm was implemented. This feature generates statistics of the average and standard deviation for a set of predefined test sites. The generated parameters include the reflectance of all the bands, the solar and viewing geometry, aerosol optical thickness from MOD04 , water vapor content, ozone concentration and surface pressure. All the results are stored as meta data in the coarse resolution product.

4. MOD09 QA plan

A QA plan labeled Version 1.2 was developed in September 1998. This plan contains a product description, a list of various factors that may affect the quality of the surface reflectance (Instrument level/ L1, L2 and L3 processing-related problems and natural conditions), description of QA procedures and software tools and criteria for data product sampling. A new version of this plan is currently being developed to take into consideration the results of the SCF and LDOPE scientists' review. The new plan will be posted on the QA homepage.

5. Development of a QA tool for MOD09

A tool based on performing atmospheric corrections using the 6S radiative transfer code was developed. This tool extracts the spectral, geometric and atmospheric information for any pixel in the L2 surface reflectance product and computes the atmospheric contribution to that pixel. By verifying the appropriate implementation of the surface reflectance algorithm, it will be used to perform sensitivity studies where the effect of variations in the atmospheric inputs on the final MOD09 product will be quantified.

6. MOD09 validation activities

This reporting period saw the completion of the coordinating for deployment and maintenance CIMEL BRDF sun photometers at USDA ARS, Beltsville, and Walker Branch, TN. CIMEL BRDF sun photometers will actively be used in the validation of the surface reflectance product.

Current plans include an experiment with Code 935 using a hyper-spectral imager onboard a model aircraft and ground measurements of surface reflectance. The purpose of this experiment is to become more knowledgeable with aircraft vs. ground-based measurements of surface reflectance and to assess the atmospheric effects on hyper-spectral images acquired from model aircraft data flying at different altitudes (yielding pixel sizes of 1, 2 and 5 meters) and making ground measurements with two ASD

spectrometers and a CIMEL sunphotometer. The starting date will be defined when an agreement is reached on the use of the ASD's.

7. Improvements to the Synthetic data generator

Radiance calculations

- a) 7 land bands (bands 1-7) uses look-up table calculated from 6S.
- b) For water pixel, 9 ocean bands (8 to 16) uses H. Gordon's code was fixed by E. Vermote and now produces "correct" reflectance for the ocean algorithm. For land pixel, 9 ocean bands (8 to 16) uses look-up table calculated from mosart1.41 (AFGL code).
- c) Short-wave IR bands (bands 17-19 and band 26) uses look-up table calculated from mosart1.41 (AFGL code).
- d) Middle-wave bands (bands 20-25) long-wave IR (bands 27-36) uses calculations from MODTRAN (version 3.7).

Over land

- a) Land cover mixture at 4km by 4km over US, and 24 class mixture at 16km by 16km over the rest of the world. A new version will include BRDF and dynamic vegetation by using inversion of LAI and directional parameter of the Kuusk model on the year of SeaWiFS produced at the SCF.
- b) Terrain height based on ETOPO5. Terrain off for a specific run.
- c) Rural aerosol type with loading pattern of varying optical depth ranging from 0.0001 to 0.1000.

8. Aerosol climatology

Effort continued to derive an aerosol climatology using AERONET measurements for use in MODIS data atmospheric correction. Code was developed to extract AERONET optical thickness values and format them in a way to facilitate their use in the computation of monthly averages. Data for approximately 132 sites for the period 1993 to 1997 were processed with this code, and monthly AM and PM averages were computed for the visible bands.

9. Aerosol retrieval from AVHRR and SeaWiFS data

Aerosol retrieval over land and ocean from AVHRR and SeaWiFS data has been applied to the period of Sept. 97 to Aug. 98 where optical thickness and the angstrom exponent from the red and near-infrared bands of SeaWiFS were generated. The current implementation of the software contains a validation site extraction feature which saves the average and standard deviation of the surface reflectance and retrieved aerosol optical thickness over AERONET sites. These statistics are used in the validation process by comparing them to AERONET measurement. This approach is identical to the validation sites feature implemented in MOD09 and serve as real life prototype.

An example of the aerosol optical thickness and angstrom exponent derived from SeaWiFS data is included in Figure 1.

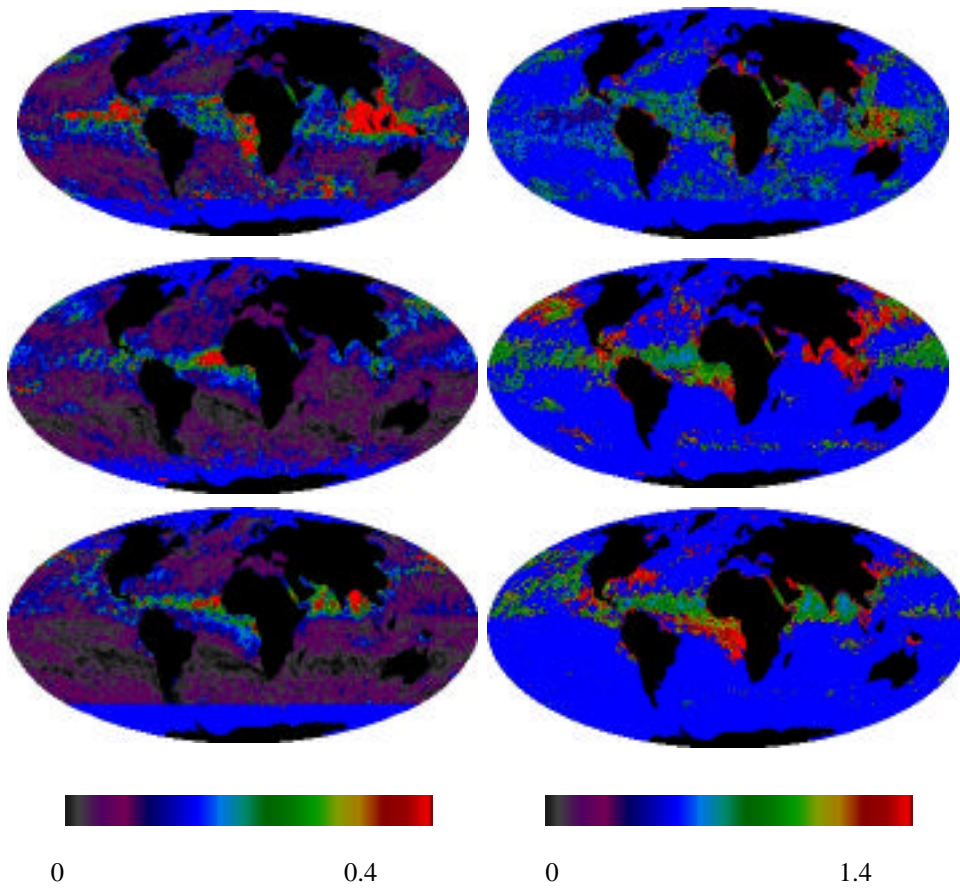


Figure 1: Example of the aerosol optical thickness (first column) and Angstrom exponent (second column) derived from SeaWiFS data. The first row shows retrieval from September 97 where smoke from the Indonesian fires is detected. The second row is from April 98 where a plume of Saharan dust is observed off the west coast of Africa. The third row is from June 98.

10. Aerosol transport modeling

Evaluation of different transport models is still underway. Models used by GSFC Data Assimilation Office (DAO) and GISS are run with different sets of input wind profiles in an attempt to reproduce the transport of known aerosol events. No decision on which model is more appropriate for our activity has been reached.

11. MEBS Week in Life Test

Our SCF was very active in the MEBS Week in Life Test (WILT). The production schedule and execution were monitored to understand and help resolve the problems that arose during the test. A large sample of the generated products was examined by the SCF scientists. Problems with different parts of the processing system and the science algorithms were identified and described. The SCF advised the MEBS team on resolving some of these problems and helped characterize problems related to the science code.

During the WILT, we tested operationally the SCF's interface to the MEBS production facility. The MOD09 coarse resolution product was pushed daily, via ftp, to the SCF where a coarse resolution Level 3 product was generated and used in the quality assessment process.

12. MODIS Adaptive Processing System (MODAPS)

We participated in the preparation of the PI processing proposal where Eric Vermote was selected the Land Team representative.

Our SCF reviewed the MODAPS Requirements Document and participated in the requirements review process.

We participated in the weekly MODAPS status meeting and are actively involved in the integration of the science code in MODAPS.

B. MEETINGS ATTENDED

- Aerosol Working group meeting, Sept. 22, Dec. 18, GSFC, Greenbelt, MD
- MEBS Week In Life Test (WILT) readiness review, Sept. 8, GSC, Lanham, MD
- MODLAND SDST Meeting, Sept. 9-10, College Park, MD
- Earth Science Enterprise/Earth Observing System (ESE/EOS) Investigators Working Group Meeting, Durham, NH, October 1998.
- MODIS Science Team Meeting Dec 15-16, College Park, MD.
- PI Processing management team meeting, Dec 15, College Park, MD
- MODLAND Day, Dec 17, GSFC, Greenbelt, MD
- DAO Data Workshop, December, GSFC, Greenbelt, MD
- MEBS WILT status weekly meetings
- MODIS Technical Team weekly meetings
- SCF weekly meetings

C. PUBLICATIONS

El Saleous, N.Z., Vermote, E.F., Justice, C.O., Townshend, J.R., Tucker, C.J., Goward, S.N., 1999, Improvements in the global biospheric record from the Advanced Very High Resolution Radiometer (AVHRR), International Journal of Remote Sensing, (accepted for publication)

Ouaidrari H. and E. Vermote, 1999, Operational Atmospheric Correction of Landsat TM data", Remote Sensing of Environment, Special Issue, In press.

Holben B.N., Eck T.F., Slutsker I., Tanré D., Buis J.P., Setzer A., Vermote E., Reagan J.A., Kaufman Y.J., Nakajima T., Lavenue F. and Jankowiak I., Smirnov A., 1998, AERONET - A federated instrument network and data archive for aerosol characterization, Remote Sensing of the Environment, 66:(1) 1-16.

Asner G.P., Bateson C.A., Privette J.L., El Saleous N.Z. and Wessman C.A., 1998, "Vegetation Structural Effects on Ecosystem Carbon Flux from Multi-satellite Data Fusion and Inverse Modeling", Journal of Geophysical Research, 103,22,28839-28853.

Plana Fattori, A., M. Legrand, C. Devaux, D. Tanré, A. Vermeulen and P. Dubuisson, 1998: "Estimating the atmospheric water vapor content from sun-photometric measurements", *Journal of Applied Meteorology*, 37(8), 790-804.